What is claimed is:

1. A method of producing purified water and sodium chloride from salt water that contains sodium chloride, the method comprising:

feeding the salt water to a reverse osmosis unit;

operating the reverse osmosis unit to separate the salt water into a permeate of purified water which is recovered and a retentate that contains sodium chloride that is concentrated with reference to the salt water;

feeding the retentate to an electrodialysis unit having a plurality of membranes, wherein at least one electrodialysis membrane is a univalent anion-selective membrane and at least one other electrodialysis membrane is a univalent cation-selective membrane;

operating the electrodialysis unit to separate the retentate into a diluate that is depleted in sodium chloride with reference to the retentate, and a concentrate that is concentrated in sodium chloride with reference to the retentate, wherein at least a portion of the diluate is recycled back to the feed to the reverse osmosis unit;

feeding the concentrate to a salt-recovery unit; and

operating the salt-recovery unit to recover sodium chloride from the concentrate.

2. The method according to claim 1, wherein the salt water is seawater or is a salt water that is different than seawater and which contains sodium chloride and magnesium and bromine, or salts thereof.

3. The method according to claim 1, wherein the electrodialysis membranes include at least one anion exchange membrane, at least one cation exchange membrane, at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

4. The method according to claim 3, wherein the electrodialysis unit comprises an anode and a cathode and wherein at least four adjacent

electrodialysis membranes are arranged in the following order from the anode to the cathode: anion exchange, cation exchange, univalent anion-selective, and univalent cation-selective, wherein the order can be optionally repeated in whole or in part within the plurality of electrodialysis membranes.

5. The method according to claim 4, wherein the retentate is fed to the electrodialysis unit between the anion exchange membrane and the cation exchange membrane, and also between the univalent anion-selective membrane and the univalent cation-selective membrane, wherein the solution exiting from between the anion exchange membrane and the cation exchange membrane is recycled to the feed to the reverse osmosis unit, and wherein all or a portion of the solution exiting from between the univalent anion-selective membrane and the univalent cation-selective membrane is optionally fed to a magnesium recovery unit, and/or is recycled by blending with salt water to make up the feed stream to the reverse osmosis unit.

6. The method according to claim 2, wherein the electrodialysis concentrate contains sodium chloride at a concentration that is higher than 20% by weight.

7. The method according to claim 2, further comprising:
removing a purge stream from either the retentate or the diluate;
feeding the purge stream to a magnesium recovery unit; and
recovering magnesium from the purge stream.

8. The method according to claim 2, further comprising:
feeding the concentrate to a crystallization unit, optionally after concentrating the concentrate stream by evaporation; and

operating the crystallization unit to produce sodium chloride crystals and a bittern that is concentrated in bromine with respect to the stream that is fed to the crystallization unit.

9. The method according to claim 7, further comprising:

feeding the bittern to a bromine recovery unit; and

operating the bromine recovery unit to recover bromine from the bittern.

10. A method of producing purified water and sodium chloride from salt water that contains sodium chloride, the method comprising:

feeding the salt water to a reverse osmosis unit;

operating the reverse osmosis unit to separate the salt water into a permeate of purified water which is recovered and a retentate that contains sodium chloride that is concentrated with reference to the salt water;

feeding the retentate to an electrodialysis unit having a plurality of membranes;

operating the electrodialysis unit to separate the retentate into a diluate that is depleted in sodium chloride with reference to the retentate, and a concentrate that is concentrated in sodium chloride with reference to the retentate;

feeding the diluate to a nanofiltration unit;

operating the nanofiltration unit to selectively concentrate divalent ions in the diluate into an NF retentate and to produce an NF permeate that is depleted of divalent ions with reference to the diluate, and wherein at least a portion of the NF permeate is recycled back to the feed to the reverse osmosis unit;

feeding the concentrate to a salt-recovery unit; and

operating the salt-recovery unit to recover sodium chloride from the concentrate.

11. The method according to claim 10, wherein the salt water is seawater or is a salt water that is different than seawater and which contains sodium chloride and magnesium and bromine, or salts thereof.

12. The method according to claim 10, wherein the electrodialysis membranes include at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

13. The method according to claim 10, wherein the electrodialysis membranes include at least one anion exchange membrane, at least one cation exchange membrane, at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

14. The method according to claim 13, wherein the electrodialysis unit comprises an anode and a cathode and wherein at least four adjacent electrodialysis membranes are arranged in the following order from the anode to the cathode: anion exchange, cation exchange, univalent anion-selective, and univalent cation-selective, wherein the order can be optionally repeated in whole or in part within the plurality of electrodialysis membranes.

15. The method according to claim 14, wherein the retentate is fed to the electrodialysis unit between the anion exchange membrane and the cation exchange membrane, and also between the univalent anion-selective membrane and the univalent cation-selective membrane, wherein the solution exiting from between the anion exchange membrane and the cation exchange membrane is recycled to the feed to the reverse osmosis unit, and wherein all or a portion of the solution exiting from between the univalent anion-selective membrane and the univalent cation-selective membrane is optionally fed to a magnesium recovery unit, or is

recycled by blending with salt water to make up the feed stream to the reverse osmosis unit.

16. The method according to claim 11, wherein the electrodialysis concentrate contains sodium chloride at a concentration that is higher than 20% by weight.

17. The method according to claim 11, further comprising:

removing a purge stream from either the retentate or the diluate;

feeding the purge stream to a magnesium recovery unit; and

recovering magnesium from the purge stream.

18. The method according to claim 11, further comprising:

feeding the concentrate stream to a crystallization unit, optionally after concentrating the concentrate stream by evaporation; and

operating the crystallization unit to produce sodium chloride crystals and a bittern that is concentrated in bromine with respect to the stream that is fed to the crystallization unit.

19. The method according to claim 18, further comprising:

feeding the bittern to a bromine recovery unit; and

operating the bromine recovery unit to recover bromine from the bittern.

20. The method according to claim 11, wherein the divalent ions that are selectively concentrated by the nanofiltration unit in the NF retentate comprise magnesium ions, and wherein the method further comprises:

feeding the NF retentate to a magnesium recovery unit;

operating the magnesium recovery unit to recover magnesium; and

recycling at least a part of the NF permeate to the feed to the reverse osmosis unit.

21. The method according to claim 20, further comprising:

reducing the calcium concentration in the NF retentate prior to feeding the NF retentate to the magnesium recovery unit.

22. The method according to claim 10, wherein the electrodialysis unit is operated at an elevated pressure.

23. The method according to claim 22, wherein the elevated pressure is optionally substantially the same as the pressure of the retentate, or is substantially the same as the pressure of the inlet of the nanofiltration unit.

24. A method of producing purified water and sodium chloride from salt water that contains sodium chloride, the method comprising:

feeding the salt water to a reverse osmosis unit;

operating the reverse osmosis unit to separate the salt water into a permeate of purified water which is recovered and a retentate that contains sodium chloride that is concentrated with reference to the salt water;

feeding the retentate to an electrodialysis unit that is designed to operate at an elevated pressure and which has a plurality of membranes;

operating the electrodialysis unit at the elevated pressure to separate the retentate into a diluate that is depleted in sodium chloride with reference to the retentate, and a concentrate that is concentrated in sodium chloride with reference to the retentate, wherein at least a portion of the diluate is recycled back to the feed to the reverse osmosis unit;

feeding the concentrate to a salt-recovery unit; and

operating the salt-recovery unit to recover sodium chloride from the concentrate.

25. The method according to claim 24, wherein the salt water is seawater or is a salt water that is different than seawater and which contains sodium chloride and magnesium and bromine, or salts thereof.

26. The method according to claim 24, wherein the electrodialysis membranes include at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

27. The method according to claim 24, wherein the electrodialysis membranes include at least one anion exchange membrane, at least one cation exchange membrane, at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

28. The method according to claim 27, wherein the electrodialysis unit comprises an anode and a cathode and wherein at least four adjacent electrodialysis membranes are arranged in the following order from the anode to the cathode: anion exchange, cation exchange, univalent anion-selective, and univalent cation-selective, wherein the order can be optionally repeated in whole or in part within the plurality of electrodialysis membranes.

29. The method according to claim 28, wherein the retentate is fed to the electrodialysis unit between the anion exchange membrane and the cation exchange membrane, and also between the univalent anion-selective membrane and the univalent cation-selective membrane, wherein the solution exiting from between the anion exchange membrane and the cation exchange membrane is recycled to the feed to the reverse osmosis unit, and wherein all or a portion of the solution exiting from between the univalent anion-selective membrane and the univalent cation-selective membrane is optionally fed to a magnesium recovery unit and/or is recycled by blending with salt water to make up the feed stream to the reverse osmosis unit.

30. The method according to claim 28, wherein the electrodialysis concentrate contains sodium chloride at a concentration that is higher than 20% by weight.

31. The method according to claim 25, further comprising:

removing a purge stream from either the retentate or the diluate;

feeding the purge stream to a magnesium recovery unit; and

recovering magnesium from the purge stream.

32. The method according to claim 25, further comprising:

feeding the concentrate to a crystallization unit, optionally after concentrating the concentrate stream by evaporation; and

operating the crystallization unit to produce sodium chloride crystals and a bittern that is concentrated in bromine with respect to the stream that is fed to the crystallization unit.

33. The method according to claim 32, further comprising:

feeding the bittern to a bromine recovery unit; and

operating the bromine recovery unit to recover bromine from the bittern.

34. The method according to claim 22, further comprising:

feeding the diluate to a nanofiltration unit;

operating the nanofiltration unit to selectively concentrate divalent ions in the diluate into an NF retentate and to produce an NF permeate that is depleted of divalent ions with reference to the diluate, and wherein at least a portion of the NF permeate is recycled back to the feed to the reverse osmosis unit;

wherein the divalent ions that are selectively concentrated by the nanofiltration unit in the NF retentate comprise magnesium ions;

feeding the NF retentate to a magnesium recovery unit;

operating the magnesium recovery unit to recover magnesium; and

recycling at least a part of the NF permeate to the feed to the reverse osmosis unit.

35. The method according to claim 34, further comprising:

reducing the calcium concentration in the NF retentate prior to feeding the NF retentate to the magnesium recovery unit.

36. The method according to claim 24, wherein the elevated pressure is substantially the same as the pressure of the retentate, or is substantially the same as the inlet pressure of the nanofiltration unit.

37. An apparatus for recovering sodium chloride and purified water from salt water containing sodium chloride, the apparatus comprising:

a pump that is designed to feed salt water from a source of salt water to

a reverse osmosis unit that is designed to produce a permeate of purified water and a retentate that contains sodium chloride that is concentrated with reference to the salt water, wherein the reverse osmosis unit is operatively connected to transfer the retentate to

an electrodialysis unit comprising a plurality of ion-exchange membranes, wherein at least one membrane is a univalent anion-selective membrane and at least one other membrane is a univalent cation-selective membrane, and wherein the electrodialysis unit is designed to separate the retentate into a diluate that is depleted in sodium chloride with reference to the retentate, and a concentrate that is concentrated in sodium chloride with reference to the retentate, wherein the electrodialysis unit is operatively connected to transfer at least a portion of the diluate to the feed to the reverse osmosis unit, and is also operatively connected to transfer the concentrate to

a salt-recovery unit that is designed to recover sodium chloride from the concentrate.

38. The apparatus according to claim 37, wherein the salt water is seawater or a salt water that is different than seawater and which contains sodium chloride and magnesium and bromine, or salts thereof.

39. The apparatus according to claim 37, wherein the electrodialysis membranes include at least one anion exchange membrane, at least one cation exchange membrane, at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

40. The apparatus according to claim 39, wherein the electrodialysis unit comprises an anode and a cathode and wherein at least four adjacent electrodialysis membranes are arranged in the following order from the anode to the cathode: anion exchange, cation exchange, univalent anion-selective, and univalent cation-selective, wherein the order can be optionally repeated in whole or in part within the plurality of electrodialysis membranes.

41. The apparatus according to claim 38, wherein the electrodialysis unit is designed to produce a concentrate that contains sodium chloride at a concentration of at least 20%.

42. The apparatus according to claim 38, further comprising:

an operative connection to transfer a purge stream from either the retentate or the diluate to a magnesium recovery unit; and wherein the salt recovery unit comprises:

an evaporator that is designed to concentrate either the retentate or the diluate to the extent that the stream is saturated in sodium chloride, and wherein the evaporator is operatively connected to a

crystallization unit that is designed to produce sodium chloride crystals and a bittern that is concentrated in bromine with respect to the stream that is fed to the crystallization unit; and

an operative connection to transfer the bittern to a bromine recovery unit that is designed to recover bromine from the bittern.

43. An apparatus for recovery of sodium chloride and purified water from salt water containing sodium chloride, the apparatus comprising:

a pump that is designed to feed salt water from a source of salt water to

a reverse osmosis unit that is designed to produce a permeate of purified water and a retentate that contains sodium chloride that is concentrated with reference to the salt water and, wherein the reverse osmosis unit is operatively connected to transfer the retentate to

an electrodialysis unit which is designed to separate the retentate into a diluate that is depleted in sodium chloride with reference to the retentate, and a concentrate that is concentrated in sodium chloride with reference to the retentate, wherein the electrodialysis unit is operatively connected to transfer the concentrate to

a salt-recovery unit that is designed to recover sodium chloride from the concentrate, and wherein the electrodialysis unit is operatively connected to transfer at least a portion of the diluate to

a nanofiltration unit that is designed to selectively concentrate divalent ions in the diluate into an NF retentate and to produce an NF permeate that is depleted of divalent ions with reference to the diluate, and wherein the nanofiltration unit is operatively connected to recycle at least a portion of the NF permeate back to the feed to the reverse osmosis unit.

44. The apparatus according to claim 43, wherein the salt water is seawater or a salt water that is different than seawater and which contains sodium chloride and magnesium and bromine, or salts thereof.

45. The apparatus according to claim 43, wherein the electrodialysis membranes include at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

46. The apparatus according to claim 43, wherein the electrodialysis membranes include at least one anion exchange membrane, at least one cation exchange membrane, at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

47. The apparatus according to claim 46, wherein the electrodialysis unit comprises an anode and a cathode and wherein at least four adjacent electrodialysis membranes are arranged in the following order from the anode to the cathode: anion exchange, cation exchange, univalent anion-selective, and univalent cation-selective, wherein the order can be optionally repeated in whole or in part within the plurality of electrodialysis membranes.

48. The apparatus according to claim 45, wherein the electrodialysis unit is designed to produce a concentrate that contains sodium chloride at a concentration that is higher than 20% by weight.

49. The apparatus according to claim 43, further comprising:

an operative connection to transfer a purge stream from either the retentate or the diluate to a magnesium recovery unit; and wherein the salt recovery unit comprises:

an evaporator that is designed to concentrate either the retentate or the diluate to the extent that the stream is saturated in sodium chloride, and wherein the evaporator is operatively connected to a

crystallization unit that is designed to produce sodium chloride crystals and a bittern that is concentrated in bromine with respect to the

stream that is fed to the crystallization unit; and wherein the apparatus further comprises

an operative connection to transfer the bittern to a bromine recovery unit that is designed to recover bromine from the bittern.

50. The apparatus according to claim 43, wherein the divalent ions that are selectively concentrated by the nanofiltration unit in the NF retentate comprise magnesium ions, and wherein the apparatus further comprises:

an operative connection to transfer retentate to

a magnesium recovery unit that is designed to recover magnesium, and which has an operative connection to recycle at least a part of the NF permeate to the feed to the reverse osmosis unit.

51. The apparatus according to claim 43, wherein the electrodialysis unit is designed to operate at an elevated pressure.

52. The apparatus according to claim 51, wherein the elevated pressure is optionally the pressure of the retentate, or the pressure of the inlet of the nanofiltration unit.

53. An apparatus for recovery of sodium chloride and potable water from salt water comprising:

a pump that is designed to feed salt water from a source of salt water to

a reverse osmosis unit that is designed to produce a permeate stream of potable water and a retentate stream that contains sodium chloride that is concentrated with reference to the salt water, and wherein the reverse osmosis unit is operatively connected to transfer the retentate to

an electrodialysis unit that is designed to operate at elevated pressure and is designed to separate its feed into a diluate that is depleted

in sodium chloride with reference to the feed, and a concentrate that is concentrated in sodium chloride with reference to the feed, wherein the electrodialysis unit is operatively connected to recycle at least a portion of the diluate back to the feed to the reverse osmosis unit, and wherein the electrodialysis unit is operatively connected to transfer the concentrate to a salt-recovery unit that is designed to recover sodium chloride from the concentrate.

54. The apparatus according to claim 53, wherein the salt water is seawater or a salt water that is different than seawater and which contains sodium chloride and magnesium and bromine, or salts thereof.

55. The apparatus according to claim 54, wherein the electrodialysis membranes include at least one univalent-anion selective membrane and at least one univalent-cation selective membrane

56. The apparatus according to claim 55, wherein the electrodialysis membranes include at least one anion exchange membrane, at least one cation exchange membrane, at least one univalent-anion selective membrane and at least one univalent-cation selective membrane.

57. The apparatus according to claim 56, wherein the electrodialysis unit comprises an anode and a cathode and wherein at least four adjacent electrodialysis membranes are arranged in the following order from the anode to the cathode: anion exchange, cation exchange, univalent anion-selective, and univalent cation-selective, wherein the order can be optionally repeated in whole or in part within the plurality of electrodialysis membranes.

58. The apparatus according to claim 54, further comprising:

an operative connection to transfer a purge stream from either the retentate or the diluate to a magnesium recovery unit; and wherein the salt recovery unit comprises:

an evaporator that is designed to concentrate either the retentate or the diluate to the extent that the stream is saturated in sodium chloride, and wherein the evaporator is operatively connected to a

crystallization unit that is designed to produce sodium chloride crystals and a bittern that is concentrated in bromine with respect to the stream that is fed to the crystallization unit; and wherein the apparatus further comprises an operative connection to transfer the bittern to a

bromine recovery unit that is designed to recover bromine from the bittern.

59. The apparatus according to claim 53, wherein the elevated pressure is substantially the same as the pressure of the retentate exiting the reverse osmosis unit.

60. The apparatus according to claim 53, wherein the electrodialysis unit is operatively connected to transfer at least a portion of the diluate to a nanofiltration unit that is designed to operate at an inlet pressure to selectively concentrate divalent ions in the diluate into an NF retentate and to produce an NF permeate that is depleted of divalent ions with reference to the diluate, and wherein the nanofiltration unit is operatively connected to recycle at least a portion of the NF permeate back to the feed to the reverse osmosis unit; and wherein the elevated pressure is substantially the same as the inlet pressure of the nanofiltration unit.